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Inventor(s) : MOTOOKA, Osamu

Title of the invention: AUTOMATIC CORRECTION APPARATUS FOR CORRECTING SOLDER DEFECT

Specification

1. Title of the invention:

Automatic correction apparatus for correcting solder defect.

2. What is claimed is:

Automatic correction apparatus for correcting a portion of solder defect on a substrate when an automatic solder inspection apparatus finds the portion on the substrate being a solder defect, comprising:

a solder removing section for removing unnecessary solder from the portion of solder defect on the substrate;

a solder feeding section for feeding a required amount of solder to the portion of solder defect on the substrate;

a positioning mechanism for positioning the portion of solder defect on the substrate with respect to each of the solder removing section and the solder feeding section; and

a controlling section for receiving information of both a position of the portion of solder defect and a type of solder defect from the automatic solder inspection apparatus and controlling an action/operation of each of the solder removing section, the solder feeding section and the position setting mechanism.

3. Detailed description of the invention

< field of industrial application>

The present invention relates to an automatic correction apparatus for correcting a portion of solder defect on a substrate when an automatic solder inspection apparatus finds the portion on the substrate being a solder defect.

<Conventional technology>

Figure 8 shows an assembly process of surface-mounted substrate, where first an automatic parts mounting device 1 mounts a predetermined

surface-mounting part at predetermined position on the substrate, and then an automatic soldering apparatus 2 solders each of the parts on the substrate. After finishing the soldering process, the substrate is transferred to an automatic solder inspection apparatus 3 where all the parts on the substrate are automatically inspected to find whether there is a solder defect or not. When a defect is not found, the substrate is transferred to the following process. When a defect is found, the substrate is transferred to a correcting process where an operator repairs the defect by hand and then transferred to the following process.

<Problems to be solved by the invention>

In the conventional operation/working system above, however, correcting the solder defect is human-intensive, which lowers an operation efficiency and makes it difficult to establish a complete automation of parts soldering process on the substrate.

The present invention has been conceived based on consideration of the above problem. An object of the present invention is therefore to provide an automatic correction apparatus for correcting a solder defect, which can improve the operation efficiency and establish the complete automation of parts soldering process. The automatic correction apparatus for correcting a solder defect can be realized by automatically correcting a portion of solder defect utilizing information of the solder defect obtained by an automatic inspection.

<Means for solving the problem>

To achieve the above object, the following apparatus was invented; that is, an automatic correction apparatus for correcting a portion of solder defect on a substrate when an automatic solder inspection apparatus finds the portion on the substrate being a solder defect, comprising:

a solder removing section for removing unnecessary solder from the portion of solder defect on the substrate;

a solder feeding section for feeding a required amount of solder to the portion of solder defect on the substrate;

a positioning mechanism for positioning the portion of solder defect on the substrate with respect to each of the solder removing section and the solder feeding section; and

a controlling section for receiving information of both a position of the portion of solder defect and a type of solder defect from the automatic solder inspection apparatus and controlling an action/operation of each of the solder removing section, the solder feeding section and the position setting

mechanism.

<Action>

When an automatic solder inspection apparatus finds a portion on the substrate being a solder defect, information of both a position of the portion of solder defect and a type of solder defect from the automatic solder inspection apparatus is sent to a controlling section. The controlling section drives the positioning mechanism according to the information to position the portion of solder defect on the substrate for the solder removing section and the solder feeding section. For example, when a type of solder defect is a bridge, the portion of the solder defect is first positioned for the solder removing section and then an excessively fed solder is removed by the solder removing section. Then the portion of the solder defect is positioned for the solder feeding section and a proper amount of new solder is fed to the portion from which old solder was removed.

<Example>

Figure 1 shows whole construction of an example of an automatic correction apparatus 4 for solder defect of the invention. Figure 2 shows process flow of assembly process of surface-mounted substrate where the automatic correction apparatus 4 is used.

In figure 2, an automatic parts mounting device 1 applies cream solder to a position on the substrate where a part is to be mounted, then mounts the part thereon. An automatic solder apparatus 2 makes the substrate pass through a reflow furnace to melt the cream solder and then move it out of the furnace to cool down the molten solder to be solidified. The substrate with solidified solder is transferred to the automatic solder inspection apparatus 3 so as to automatically inspect all the parts mounted on the substrate to find a solder defect. When no solder defect is found, the substrate without solder defect is transferred directly to the following process, and when some solder defect is found, the substrate with some defect is transferred to the automatic correction apparatus 4 of the invention where a portion of solder defect is automatically corrected and the substrate is sent to the next process. The automatic correction apparatus 4 comprises, as shown in figure 1, a solder removing section 5, a solder feeding section 6, a heating section 7, s positioning mechanism 8 and a controlling section 9. The controlling section 9 receives information of both a position of the portion of solder defect and a type of solder defect from the automatic solder inspection apparatus 3.

The solder removing section 5 includes a solder suction device 10 and a controller 11 therefor, and the solder suction device 10 removes by sucking an

excessive or unnecessary solder from the portion of solder defect.
The solder feeding section 6 includes a solder dispenser 12 and a controller 13 therefor. The solder dispenser 12 feeds a required amount of solder to the portion of solder defect.

The heating section 7 includes a locally heating device 14 and a controller 15 therefor. The locally heating device 14 can heat locally the portion to which cream solder was fed by using laser beam or infra-red ray to melt the cream solder so as to be solidified later.. Each of controllers 11, 13 and 15 drives the solder suction device 10, the solder dispenser 12 and/or the locally heating device 14 in accordance with information of type of solder defect, i.e., bridge, lack of solder or insufficient amount of solder. The information of type of solder defect is provided by the controlling section.

The positioning mechanism 8 includes a X-Y stage 16 for supporting a substrate having solder defect and a NC controller 17 for controlling movements of the X-Y stage 16 in both X axis direction and Y axis direction. The NC controller 17 can position a portion of solder defect on the substrate 18 having solder defect for each of the solder suction device 10, the solder dispensed 12 and the locally heating device 14.

Figure 3 indicates procedure of substrate assembly process. Parts are mounted at step 1 (represented by ST1 in the drawings) by the automatic parts mounting device 1, soldering of the parts is carried out by the automatic soldering apparatus 2 at step 2, and then the parts-mounted substrate is inspected by the automatic solder inspection apparatus 3 to check whether there is the solder defect. At step 3 where it is determined whether the substrate is normal (no defect), a lack of solder or (no defect), the substrate is transferred to the next process and if the determination is "NO", the substrate is transferred to the automatic correcting process where the solder defect portion is corrected by the automatic correction apparatus 4.
At step 4, a type of solder defect is determined. If the solder defect is due to excess amount of solder such as bridge, the step 4 results in "YES", at the following steps 5 – 7, removal of solder by the solder removing section 5, feeding of solder by the solder feeding section 6 and soldering by the heating section 7 are performed respectively in order.
Figure 4 illustrates the process of bridge correction where a bridge is formed over two adjacent lead wires 20 and 21 of part 19. After the solder suction

device 10 of solder removing section 5 sucked the bridge of excess amount solder 21, the solder dispenser 12 of solder feeding section 6 feeds a proper amount of cream solder 22 to the relevant portion. Then the locally heating device 14 of heating section 7 irradiates laser beam or the like toward the portion where the cream solder was fed to melt the cream solder 22, and finally the solder is solidified.

At the step 4 in the figure 3, if the solder defect is determined an insufficient amount of solder such as a lack of solder, the step 4 results in "NO", i.e., step 5 is skipped, and solder feeding by solder feeding section 6 and soldering by heating section 7 are carried out in order at steps 6 and 7.

Figure 5 shows a process for correcting the lack-of-solder defect. In a part 19, one of electrodes shows a lack-of-solder 23. In this case, the solder dispenser 12 of the solder feeding section 6 feeds a proper amount of solder to the position of the lack of solder. Then the locally heating device 14 of heating section 7 irradiates laser beam or the like toward the portion where the cream solder 24 was fed to melt the cream solder 24, and finally the solder is solidified.

Figure 6 shows another example of the invention. In this example, the automatic soldering apparatus 2 is used also for correcting solder defect. Therefore the example does not have a heating section 7 which is solely used for correcting a solder defect as in the previously described examples. Accordingly after cream solder is fed to a position of solder defect by the solder feeding section 6, the substrate is moved back to the automatic soldering apparatus 2, then passed through the reflow furnace to melt and solidify the cream solder. Then the substrate is inspected again by the automatic solder inspection apparatus 3. Figure 7 shows procedure of substrate assembly process, i.e., when solder feeding step 6 for feeding cream solder by the solder feeding section 6 is finished, the substrate is returned to step 2 where automatic soldering is carried out by the automatic soldering apparatus 2.

<Effects of the invention>

As described above, a portion of solder defect is automatically corrected by controlling the action of each of a solder removing section, a solder feeding section and a positioning mechanism with utilizing information of a position and a type of solder defect obtained through an automatic solder inspection. This makes it possible to improve an operation efficiency and realize a complete automation of parts soldering process.

4. Brief description of the drawings

Figure 1 is an explanatory diagram showing whole construction of an example of an automatic correction apparatus for solder defect of the invention.
Figure 2 is a block diagram showing assembly process of surface-mounted substrate where the automatic correction apparatus 4 is used.
Figure 3 is a flow chart indicating procedure of substrate assembly process.
Figure 4 is an explanatory diagram illustrating a process of correcting a bridge.
Figure 5 is an explanatory diagram illustrating a process of correcting a lack-of-solder.
Figure 6 is a block diagram showing another example of substrate assembly process of the invention.
Figure 7 is a flow chart showing procedure of substrate assembly process in the example of Figure 6.
Figure 8 is a block diagram showing prior art of substrate assembly process.

3 · · · · · automatic solder inspection apparatus
4 · · · · · automatic correction apparatus
5 · · · · · solder removing section
6 · · · · · solder feeding section
8 · · · · · positioning mechanism
9 · · · · · controlling section

4．図面の簡単な説明

第1図はこの発明の一実施例にかかる半田不良の自動修正装置の全体構成を示す説明図、第2図はこの発明の自動修正装置が導入された基板組立工程を示すブロック図、第3図は基板組立手順の流れを示すフローチャート、第4図はブリッジの修正過程を示す説明図、第5図は半田の欠落の修正過程を示す説明図、第6図はこの発明の他の実施例による基板組立工程を示すブロック図、第7図は第6図の実施例による基板組立手順の流れを示すフローチャート、第8図は従来の基板組立工程を示すブロック図である。

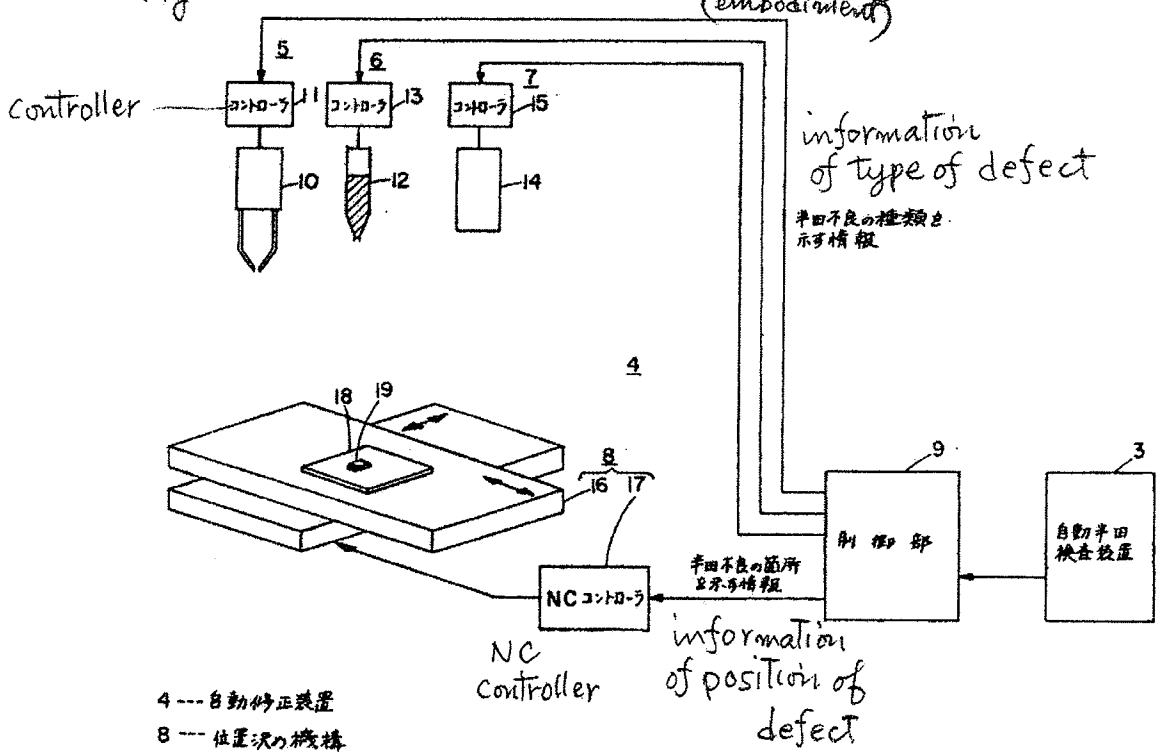
automatic parts mounting device 1
surface-mounted substrate
surface mounting part
automatic soldering apparatus 2

3・・・・自動半田検査装置 automatic solder inspection apparatus 3
4・・・・自動修正装置 automatic correction apparatus 4
5・・・・半田除去部　6・・・・半田供給部
8・・・・位置決め機構　9・・・・制御部

特許出願人　立石電機株式会社
代理人　弁理士　鈴木由充

第1図　この発明の一実施例における半田不良の自動修正装置の全体構成を示す説明図

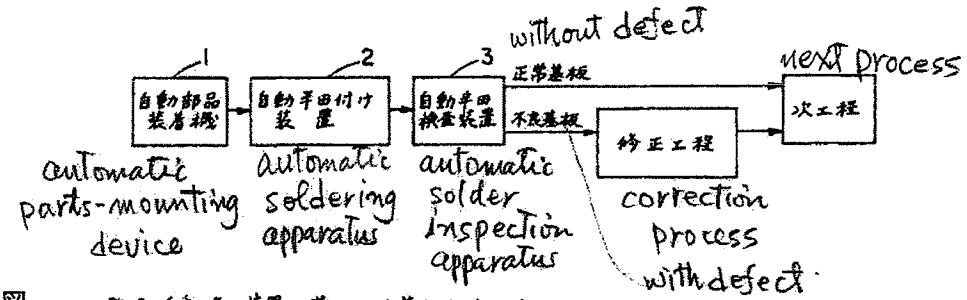
Figure 1　whole construction of example of the invention (embodiment)



4---自動修正装置
8---位置決め機構

Figure 8 prior art

第 8 図 従来の基板組立工程を示すブロック図



第 2 図 この発明の自動修正装置が導入された基板組立工程を示すブロック図

Figure 2 substrate assembly process of the invention

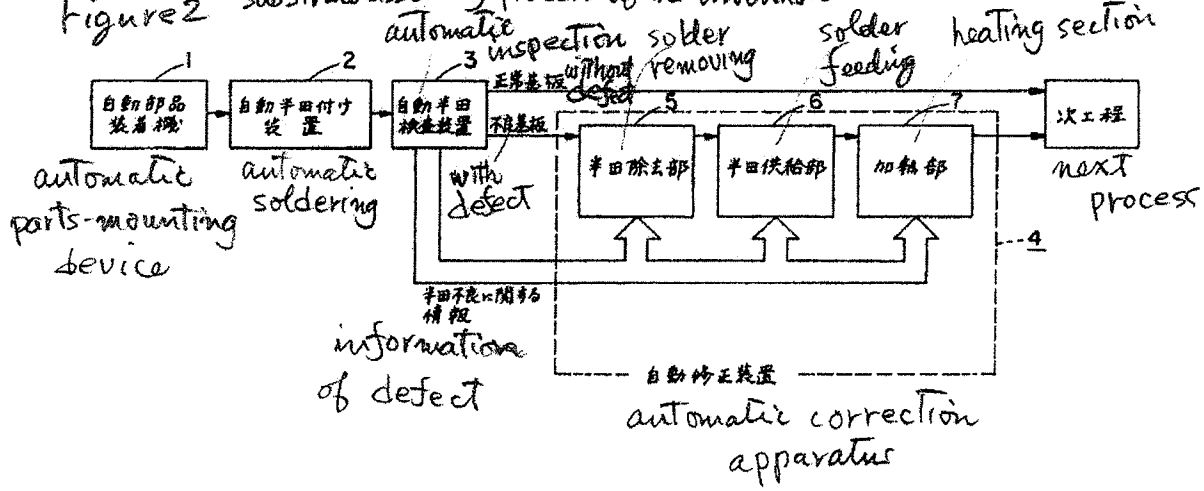
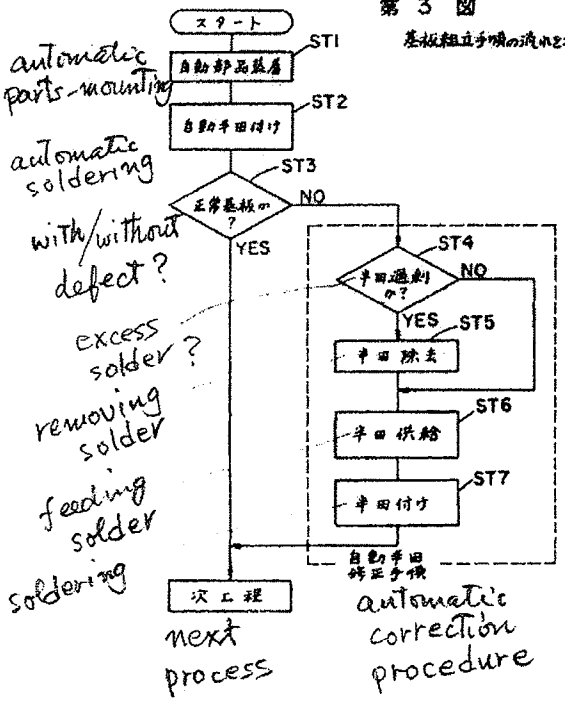


Figure 3.

第 3 図 基板組立手順の流れを示すフローチャート



correction for lack of solder

第 5 図 半田の欠落の修正過程を示す説明図

Figure 5

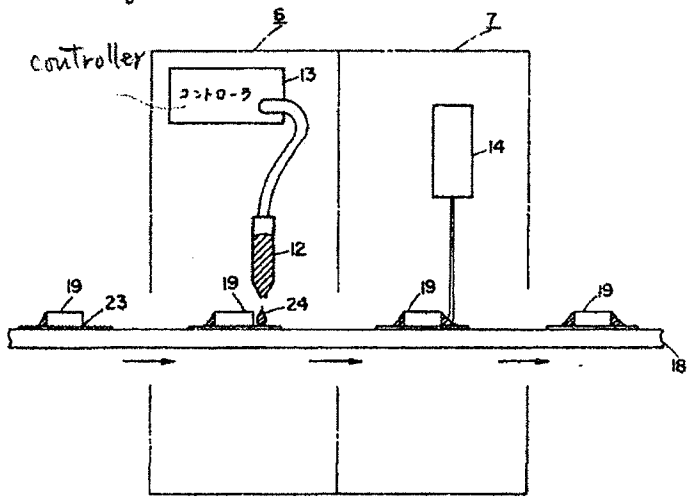


Figure 4

第 4 図

ブリッジの修正過程を示す説明図

correction of bridge

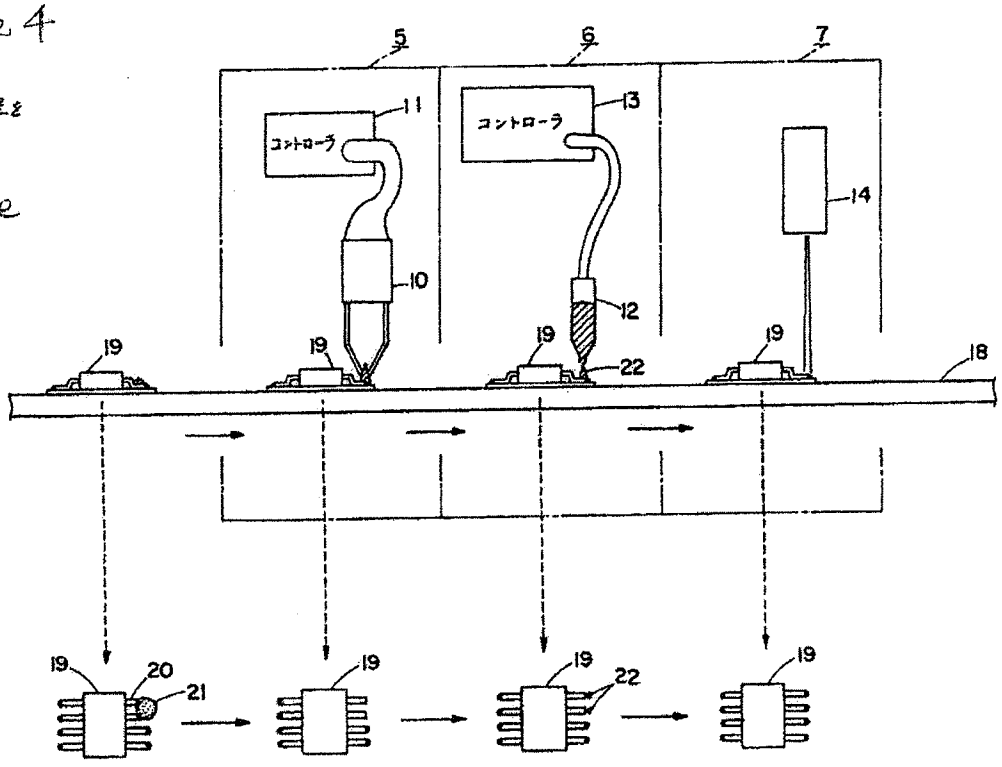


Figure 6 another example

第 6 図 この発明の他の実施例による基板組立工程を示すブロック図

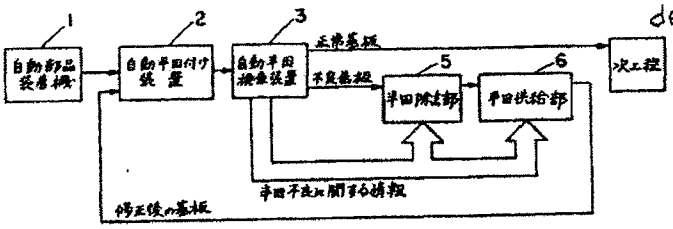


Figure 7. Flowchart of Figure 6.

第 7 図 第6図の実施例による基板組立工程の流れを示すフローチャート